SYLLABUS:

Application of remote sensing and geographic information systems to environmental research

Course name: Application of remote sensing and geographic information systems to environmental research
Course index: ENVI402
Number of credits: 6 ECTS/3 MCTS
Period: Fall/Spring semester

Host institution	National University of Mongolia, School of Engineering and Applied Sciences
Lecturer	Professor Ochir Altansukh
Level	Bachelor course
Course type	Major compulsory course
Course duration	16 weeks
New/Revised	Revised course, previous version was developed in 2015
E-course link	https://online.num.edu.mn/courses/course-v1:NUM+ENVI402+2022/course/
Language	Available in Mongolian language, only

Summary

This course is about fundamental understanding of geographic information system (GIS), remote sensing (RS) and its application for environmental study. It consists of 16 video lectures, 16 video laboratory works and supplementary study materials that use in the laboratory classes. The following contents are included in the lecture: introduction to GIS, the real world and representations of it, geographic information and spatial data types, organizing one's spatial data, the temporal dimension, data processing systems, stages of spatial data handling, database management systems, metadata, determining and mapping position, data quality, spatial referencing, measures of location error on maps, satellite-based positioning. In the laboratory, GIS-RS application, topo map, spatial visualization, spatial data characteristics, metadata, map development and satellite image processing are included.

Target audiences

~ Bachelor students who are majoring in environmental science, environmental management.
~ Open for life-long learners who are interesting GIS and its application at the fundamental level.

Prerequisites

Pre-required courses:

1. Environmental science ENVI200
2. Environmental monitoring ENVI301

Parallel course (only suggestion):

1. Environmental modeling ENVI404

Aims and objectives

The course objective is to provide knowledge about the basic concepts of geographic information systems (GIS) and remote sensing (RS) through lectures, and to teach its application in environmental research through laboratory classes. By studying the course, the student and life-long learners will acquire the ability to develop a map using the results of research.

The authentic tasks

The authentic tasks are:

- ~ Read the core study book of the course and answer self-testing questions of each section
- ~ Install ArcGIS software for the laboratory class and download the provided dataset
- ~ Independently prepare a visual map using the datasets and snow it at the end of the course

General learning outcomes:

By the end of the course, successful students and life-long learners will:

Knowledge	~ geographic information and spatial data types ~ the temporal dimension ~ data processing systems ~ database management systems, metadata ~ data quality ~ spatial referencing ~ satellite-based positioning and etc.
Comprehensive	~ self-learning ~ team working ~ learning in practice ~ technology literacy ~ lifelong learning ~ practical application
Application	~ organizing spatial data ~ determining and mapping position ~ developing map ~ satellite image processing
Analysis	~ spatial data analysis ~ temporal data analysis ~ creativity
Synthesis	~ data gathering and combining ~ visual map developing

Overview of sessions and teaching methods

The course will conduct online form that means students and life-long learners no longer needed to come to the university for the lecture class. For the laboratory work, students and life-long learners can come to the class, if they need. GIS laboratory will be available during the course. Most of the interactive and self-reflective methods of teaching-learning will be applied to the course, where possible, avoid standing lectures and presentations. All video lectures, and laboratory works were prepared and embedded in OpenEDX based online learning platform of the university.

Learning methods	~ video presentations ~ group and independent work ~ project based learning ~ data analysis
Course outline	Week 1: Introduction to GIS Week 2: The real world and its representations Week 3: Geographic phenomena Week 4: Geographic information representation Week 5: Spatial scale and resolution, organizing spatial data Week 6: Stages of spatial data handling Week 7: Database management systems Week 8: Determining and mapping position, data quality

Week 9: Spatial referencing, measures of location error on maps
Week 10: Satellite-based positioning
Week 11: Data entry and preparation
Week 12: Interpolation and advanced operation on raster dataset
Week 13: Spatial data analysis
Week 14: Data visualization
Week 15: Cartographic tool and map development

Course workload

The table below summarizes course workload distribution:

Activities	Learning outcomes	Assessment	Workload (hours)
In-class activities – 50 hours			
Lectures	Understanding theories, concepts, methodology and tools	Class participation	36
Moderated in-class discussions	Understanding various contexts and common problems in GIS/RS application	Class participation and preparedness for discussions	4
Homework assignments	Understanding various contexts and common problems in GIS/RS application to environmental study		3
Watching and discussion of video guidelines for laboratory	Understand step-be-step approach to each laboratory work	Class participation, contribution to discussion	3
Examination	Measure students' knowledge and understanding at the end of a course	Individual assessment	4
Independent work – 100 hours			
Group work	Ability to collect, create and interpret spatio-temporal data, to analyze datasets, and to apply the theoretical knowledge to the practice	Quality of group work	4
Assignment	Ability to determine spatial data types and the temporal dimension, to process spatial data, to develop metadata, to check data quality, to determine spatial referencing and etc.	Quality of individual presentations	20
Map development	Ability to interpret data, to develop and visualize map, to apply different types of spatial data, to apply the theoretical knowledge to the practice	Quality of printed map	8
Exam preparation	Measure students' knowledge and understanding at the end of a course	Individual assessment	4
E-learning	Ability to learn individually	Answers of key questions	64
Total			**150**

Grading

The students' and life-long learner's performance will be based on the following:

Assessment

- Attendance (20%): based on watching e-learning videos and answer the key questions of each lecture class
- Progress assessment (20%): based on the mid-term exam after the 7th lecture class when completing chapters 1-3 of the core study book
- Final assessment (30%): based on the final exam after all lecture class when completing chapters 4-7 of the core study book at the end of the semester
- Skill test (30%): based on the quality of the individually developed map at the end of the laboratory class

Evaluation EU system	A (8,5 – 10) B (7,0 – 8,4) C (5,5 - 6,9) D (4,0 – 5,4)	Evaluation MN system	95-100 90-94 85-89 80-84 75-79 70-74 65-69 60-64 0-59	A A- B B- C C- D D- F	4.0 3.6 3.1 2.7 2.3 1.9 1.4 1.0 0.0

Course schedule – Lecture

Week	Topic	Class hours	Content
1	Introduction to GIS	2	Natural phenomena, GIS definition, spatial data and geo-information
2	The real world and its representations	2	Modeling, map, database, spatial database
3	Geographic phenomena	2	Geographic phenomena definition, different types of it, geographic field and object, boundary
4	Geographic information representation	2	Regular and irregular tessellation, vector representation, topology and spatial relationship, representations of geographic field and object
5	Spatial scale and resolution, organizing spatial data	2	Scale and resolution, organizing spatial data, temporal dimension
6	Stages of spatial data handling	2	Spatial data capture, preparation, storage and maintenance, spatial analysis and presentation
7	Database management systems	2	Alternatives for data management, relational data model, querying the database, using GIS and DBMS together
8	Determining and mapping position, data quality	2	Accuracy and precision, attribute and temporal accuracy, spatial referencing system
9	Spatial referencing, measures of location error on maps	2	Spatial referencing system, frame and datum, map projection, location error on map
10	Satellite-based positioning	2	Absolute, relative and network positioning, positioning technology
11	Data entry and preparation	2	Spatial data input, digitizing, data check and repair, combining multiple data sources
12	Interpolation and advanced operation on raster dataset	2	Point data transformation, advanced operation on raster dataset, filtering, computation of slope
13	Spatial data analysis – 1	2	Retrieval, classification, measurement and overlay functions
14	Spatial data analysis – 2	2	Neighborhood, proximity, spread, seek computations, network analysis
15	Data visualization	2	GIS and map, visualization process, cartography
16	Cartographic tool and map development	2	Mapping of qualitative and quantitative data, terrain elevation, time series, map cosmetics and dissemination

Course schedule – Laboratory

Week	Topic	Class hours	Content
1	Geographic coordinate, topo map	2	Introduction to geographic coordinate system, topo map interpretation and information on the map
2	GIS software	2	ArcGIS software and its functions
3	Geo-referencing of topo map	2	Topo map geo-referencing using 4 and 9 tie points

4	Spatial data analysis	2	Primary analysis of spatial data, merging, clip, buffer zone
5	Shape data	2	Creating shape data, geodatabase
6	Shape data conversion	2	Converting shape data between ArcGIS and Google Earth
7	Attribute data	2	Nominal, ordinal, interval, ratio data values, tabular dataset
8	Attribute data analysis	2	Statistical analysis of attribute data, convert it into Excel software
9	Map development – 1	2	Temporal representation, thematic map, visualization process
10	Map development – 2	2	Visualization types depend on data type, Bertin categories, visual variables
11	Map development – 3	2	Map cosmetics, title, scale, north arrow, image, legend, projection, bibliographic information
12	Map printing and wrap-up	2	Prepare digital map to print version, convert it into image file
13	Digital elevation model	2	Introduction to DEM, download it, processing, application
14	Satellite data	2	Introduction to satellite data, download it, band combination
15	Normalized difference vegetation index	2	Introduction to NDVI, its process and interpretation
16	Normalized difference water index	2	Introduction to NDWI, its process and interpretation

Course assignments/tests

Course assignment consists of three parts, progress, final and skill tests. Questions of the progress and the final tests will come from the core study book, namely “Principles of geographic information system”. The skill test will score on the basis of quality of the individually developed map which students and life-long learners work entire laboratory classes.

Supplementary materials

The following study materials will be used for the course.

~ ArcGIS software
~ Topo map
~ Satellite image

Literature

Compulsory:

1. Altansukh.O and et al, (2016) “Principles of geographic information system”, editors Bolorchuluun.N and V.Battsengel, 2nd edition of translation of ITC course book, NUM Press, Ulaanbaatar, pages 347, ISBN: 999733220-2, in Mongolian.
2. National agency for geodesy and cartography, (2001) “Legends of 1:25000, 1:50000, 1:100000 scaled topo map”, editors Sanjaajamts.J and Oyunchimeg.B, The color printing, Ulaanbaatar, pages 72, in Mongolian.

Recommended:

3. Amarsaikhan.D and et al, (2014) “Application of remote sensing and geographic information systems to natural resource management”, Admon Press, Ulaanbaatar, pages 168, in Mongolian.